

TL071, TL071A, TL071B, TL072
TL072A, TL072B, TL074, TL074A, TL074B
LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS
 SLOS080D – SEPTEMBER 1978 – REVISED AUGUST 1996

- Low Power Consumption
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias and Offset Currents
- Output Short-Circuit Protection
- Low Total Harmonic Distortion
0.003% Typ
- Low Noise
 $V_n = 18 \text{ nV}/\sqrt{\text{Hz}}$ Typ at $f = 1 \text{ kHz}$
- High Input Impedance . . . JFET Input Stage
- Internal Frequency Compensation
- Latch-Up-Free Operation
- High Slew Rate . . . $13 \text{ V}/\mu\text{s}$ Typ
- Common-Mode Input Voltage Range
Includes V_{CC+}

description

The JFET-input operational amplifiers in the TL07_ series are designed as low-noise versions of the TL08_ series amplifiers with low input bias and offset currents and fast slew rate. The low harmonic distortion and low noise make the TL07_ series ideally suited for high-fidelity and audio preamplifier applications. Each amplifier features JFET inputs (for high input impedance) coupled with bipolar output stages integrated on a single monolithic chip.

The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from –40°C to 85°C. The M-suffix devices are characterized for operation over the full military temperature range of –55°C to 125°C.

AVAILABLE OPTIONS

TA	V _{IO} max AT 25°C	PACKAGE							
		SMALL OUTLINE (D)†	CHIP CARRIER (FK)	CERAMIC DIP (J)	CERAMIC DIP (JG)	PLASTIC DIP (N)	PLASTIC DIP (P)	TSSOP PACKAGE (PW)	FLAT PACKAGE (W)
0°C to 70°C	10 mV 6 mV 3 mV	TL071CD TL071ACD TL071BCD	—	—	—	—	TL071CP TL071ACP TL071BCP	TL071CPWLE — —	—
	10 mV 6 mV 3 mV	TL072CD TL072ACD TL072BCD	—	—	—	—	TL072CP TL072ACP TL072BCP	TL072CPWLE — —	—
	10 mV 6 mV 3 mV	TL074CD TL074ACD TL074BCD	—	—	—	TL074CN TL074ACN TL074BCN	—	TL074CPWLE — —	—
–40°C to 85°C	6 mV	TL071ID TL072ID TL074ID	—	—	—	— — TL074IN	TL071IP TL072IP —	—	—
–55°C to 125°C	6 mV 6 mV 9 mV	—	TL071MFK TL072MFK TL074MFK	— — TL074MJ	TL071MJG TL072MJG —	— — TL074MN	— TL072MP —	—	— — TL074MW

† The D package is available taped and reeled. Add the suffix R to the device type (e.g., TL071CDR). The PW package is only available left-ended taped and reeled (e.g., TL072CPWLE).



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PRODUCTION DATA Information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS
INSTRUMENTS**

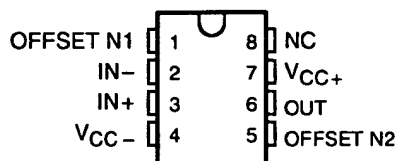
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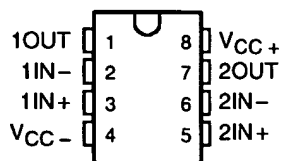
TL071, TL071A, TL071B, TL072 **TL072A, TL072B, TL074, TL074A, TL074B** **LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

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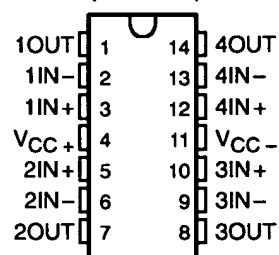
TL071, TL071A, TL071B
D, JG, P, OR PW PACKAGE
(TOP VIEW)



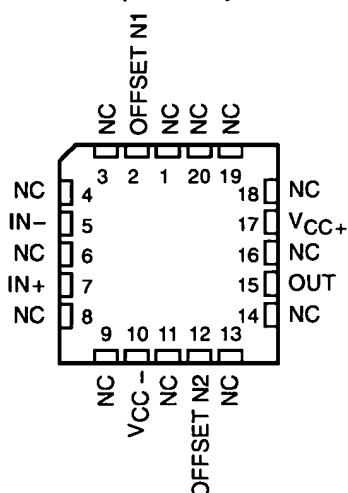
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D, JG, P, OR PW PACKAGE
(TOP VIEW)



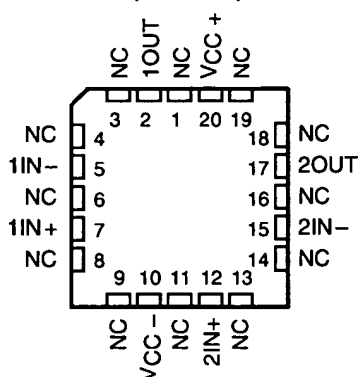
TL074, TL074A, TL074B
D, J, N, OR PW PACKAGE
TL074...W PACKAGE
(TOP VIEW)



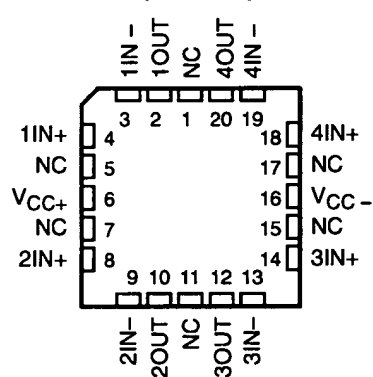
TL071
FK PACKAGE
(TOP VIEW)



TL072
FK PACKAGE
(TOP VIEW)



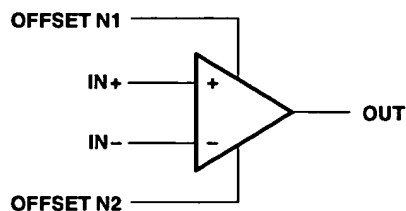
TL074
FK PACKAGE
(TOP VIEW)



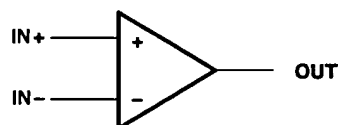
NC – No internal connection

symbols

TL071

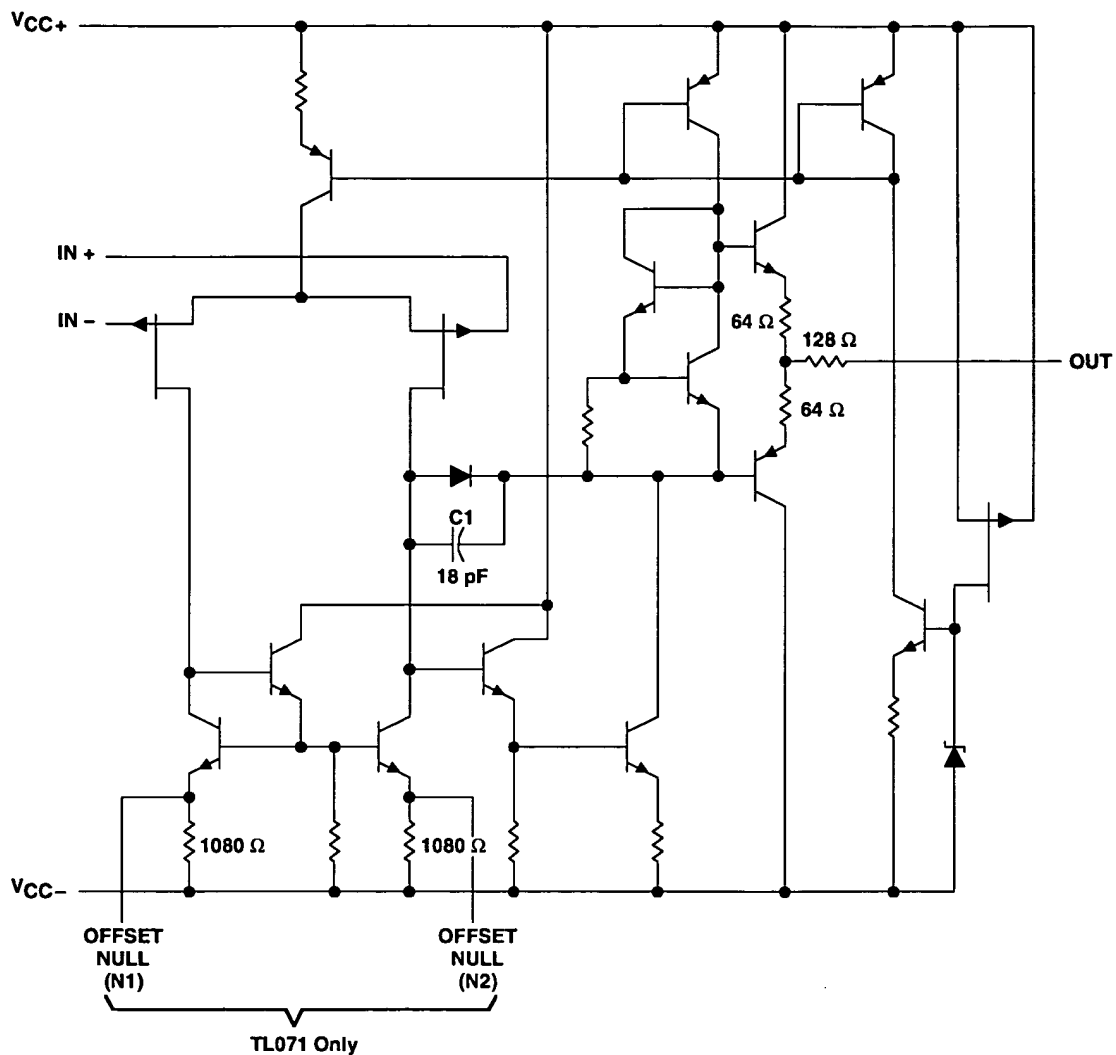


TL072 (each amplifier)
TL074 (each amplifier)



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TL072A, TL072B, TL074, TL074A, TL074B
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schematic (each amplifier)



All component values shown are nominal.

COMPONENT COUNT†			
COMPONENT TYPE	TL071	TL072	TL074
Resistors	11	22	44
Transistors	14	28	56
JFET	2	4	6
Diodes	1	2	4
Capacitors	1	2	4
epi-FET	1	2	4

† Includes bias and trim circuitry

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Supply voltage, V_{CC+} (see Note 1)	18 V
Supply voltage, V_{CC-} (see Note 1)	-18 V
Differential input voltage, V_{ID} (see Note 2)	± 30 V
Input voltage, V_I (see Notes 1 and 3)	± 15 V
Duration of output short circuit (see Note 4)	unlimited
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A : C suffix	0°C to 70°C
I suffix	-40°C to 85°C
M suffix	-55°C to 125°C
Storage temperature range	-65°C to 150°C
Case temperature for 60 seconds: FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: J, JG, or W package	300°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, N, P, or PW package	260°C

NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-} .

- ### DISSIPATION RATING TABLE

PACKAGE	T _A ≤ 25°C POWER RATING	DERATING FACTOR	DERATE ABOVE T _A	T _A = 70°C POWER RATING	T _A = 85°C POWER RATING	T _A = 125°C POWER RATING
D (8 pin)	680 mW	5.8 mW/°C	33°C	465 mW	378 mW	N/A
D (14 pin)	680 mW	7.6 mW/°C	60°C	604 mW	490 mW	N/A
FK	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	273 mW
J	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	273 mW
JG	680 mW	8.4 mW/°C	69°C	672 mW	546 mW	210 mW
N	680 mW	9.2 mW/°C	76°C	680 mW	597 mW	N/A
P	680 mW	8.0 mW/°C	65°C	640 mW	520 mW	N/A
PW (8 pin)	525 mW	4.2 mW/°C	70°C	525 mW	N/A	N/A
PW (14 pin)	700 mW	5.6 mW/°C	70°C	700 mW	N/A	N/A
W	680 mW	8.0 mW/°C	65°C	640 mW	520 mW	200 mW

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electrical characteristics, $V_{CC} = \pm 15$ V (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	T _A ‡	TL071C TL072C TL074C			TL071AC TL072AC TL074AC			TL071BC TL072BC TL074BC			TL071I TL072I TL074I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	Input offset voltage V _O = 0, R _S = 50 Ω	25°C Full range	3	10	13		3	6	2	3	5	3	6	8	mV
αV _{IO}	Temperature coefficient of input offset voltage	Full range		18			18			18			18		μV/°C
I _{IO}	Input offset current V _O = 0	25°C Full range	5	100	10	5	100	2	5	100	2	5	100	2	pA
I _{IB}	Input bias current§ V _O = 0	25°C Full range	65	200	7	65	200	200	65	200	200	65	200	200	nA
V _{ICR}	Common-mode input voltage range	25°C	±11	-12 to 15		±11	-12 to 15		±11	-12 to 15		±11	-12 to 15		V
V _{OM}	Maximum peak output voltage swing R _L = 10 kΩ R _L ≥ 10 kΩ R _L ≥ 2 kΩ	25°C Full range	±12	±13.5		±12	±13.5		±12	±13.5		±12	±13.5		V
A _{VD}	Large-signal differential voltage amplification V _O = ±10 V, R _L ≥ 2 kΩ	25°C Full range	25	200	15	50	200	25	50	200	25	50	200	25	V/mV
B ₁	Unity-gain bandwidth	25°C	3			3			3			3			MHz
r _i	Input resistance	25°C	10 ¹²			10 ¹²			10 ¹²			10 ¹²			Ω
CMRR	Common-mode rejection ratio V _{IC} = V _{ICRmin} , V _O = 0, R _S = 50 Ω	25°C	70	100		75	100		75	100		75	100		dB
k _{SVR}	Supply-voltage rejection ratio (ΔV _{CC} /ΔV _{IO}) V _{CC} = ±9 V to ±15 V, V _O = 0, R _S = 50 Ω	25°C	70	100		80	100		80	100		80	100		dB
I _{CC}	Supply current (each amplifier) V _O = 0, No load	25°C	1.4	2.5		1.4	2.5		1.4	2.5		1.4	2.5		mA
V _{O1} /V _{O2}	Crosstalk attenuation A _{VD} = 100	25°C	120			120			120			120			dB

† All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified.

‡ Full range is T_A = 0°C to 70°C for TL07_C, TL07_AC, TL07_BC and is T_A = -40°C to 85°C for TL07_I.

§ Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 4. Pulse techniques must be used that maintain the junction temperature as close to the ambient temperature as possible.

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electrical characteristics, $V_{CC\pm} = \pm 15$ V (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	T_A ‡	TL071M TL072M			TL074M			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_O = 0$, $R_S = 50 \Omega$	25°C		3	6		3	9	mV
		Full range			9			15	
α_{VIO} Temperature coefficient of input offset voltage	$V_O = 0$, $R_S = 50 \Omega$	Full range		18			18		$\mu V/^\circ C$
I_{IO} Input offset current	$V_O = 0$	25°C		5	100		5	100	pA
		Full range			20			20	nA
I_{IB} Input bias current‡	$V_O = 0$	25°C		65	200		65	200	pA
					50			50	nA
V_{ICR} Common-mode input voltage range		25°C	± 11	-12 to 15		± 11	-12 to 15		V
V_{OM} Maximum peak output voltage swing	$R_L = 10 k\Omega$	25°C	± 12	± 13.5		± 12	± 13.5		V
	$R_L \geq 10 k\Omega$	Full range	± 12			± 12			
	$R_L \geq 2 k\Omega$		± 10			± 10			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 10$ V, $R_L \geq 2 k\Omega$	25°C	35	200		35	200		V/mV
			15			15			
B_1 Unity-gain bandwidth	$T_A = 25^\circ C$			3			3		MHz
r_i Input resistance	$T_A = 25^\circ C$			10^{12}			10^{12}		Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$, $V_O = 0$, $R_S = 50 \Omega$	25°C	80	86		80	86		dB
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC} = \pm 9$ V to ± 15 V, $V_O = 0$, $R_S = 50 \Omega$	25°C	80	86		80	86		dB
I_{CC} Supply current (each amplifier)	$V_O = 0$, No load	25°C		1.4	2.5		1.4	2.5	mA
V_{O1}/V_{O2} Crosstalk attenuation	$A_{VD} = 100$	25°C		120			120		dB

† Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 4. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as possible.

‡ All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified. Full range is $T_A = -55^\circ C$ to $125^\circ C$.

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operating characteristics, $V_{CC\pm} = \pm 15\text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TL07xM			ALL OTHERS			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_I = 10\text{ V}$, $C_L = 100\text{ pF}$, $R_L = 2\text{ k}\Omega$, See Figure 1	5	13		8	13		V/ μs
t_r Rise time overshoot factor	$V_I = 20\text{ mV}$, $C_L = 100\text{ pF}$, $R_L = 2\text{ k}\Omega$, See Figure 1		0.1 20%			0.1 20%		μs
V_n Equivalent input noise voltage	$R_S = 20\text{ }\Omega$		$f = 1\text{ kHz}$ $f = 10\text{ Hz to } 10\text{ kHz}$	18 4		18 4		nV/ $\sqrt{\text{Hz}}$ μV
I_n Equivalent input noise current	$R_S = 20\text{ }\Omega$, $f = 1\text{ kHz}$		0.01			0.01		pA/ $\sqrt{\text{Hz}}$
THD Total harmonic distortion	$V_{I\text{rms}} = 6\text{ V}$, $R_L \geq 2\text{ k}\Omega$, $f = 1\text{ kHz}$ $A_{VD} = 1$, $R_S \leq 1\text{ k}\Omega$		0.003%			0.003%		

PARAMETER MEASUREMENT INFORMATION

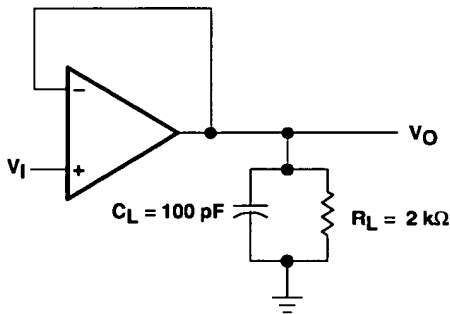


Figure 1. Unity-Gain Amplifier

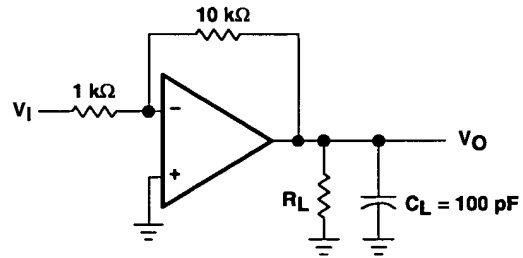


Figure 2. Gain-of-10 Inverting Amplifier

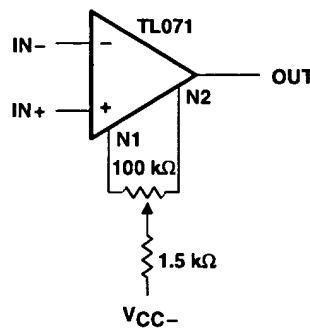


Figure 3. Input Offset Voltage Null Circuit

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TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
I_B	Input bias current	vs Free-air temperature	4
V_{OM}	Maximum output voltage	vs Frequency	5, 6, 7
		vs Free-air temperature	8
		vs Load resistance	9
		vs Supply voltage	10
A_{VD}	Large-signal differential voltage amplification	vs Free-air temperature	11
		vs Frequency	12
	Phase shift	vs Frequency	12
	Normalized unity-gain bandwidth	vs Free-air temperature	13
	Normalized phase shift	vs Free-air temperature	13
CMRR	Common-mode rejection ratio	vs Free-air temperature	14
I_{CC}	Supply current	vs Supply voltage	15
		vs Free-air temperature	16
P_D	Total power dissipation	vs Free-air temperature	17
	Normalized slew rate	vs Free-air temperature	18
V_n	Equivalent input noise voltage	vs Frequency	19
THD	Total harmonic distortion	vs Frequency	20
	Large-signal pulse response	vs Time	21
V_O	Output voltage	vs Elapsed time	22



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TYPICAL CHARACTERISTICS†

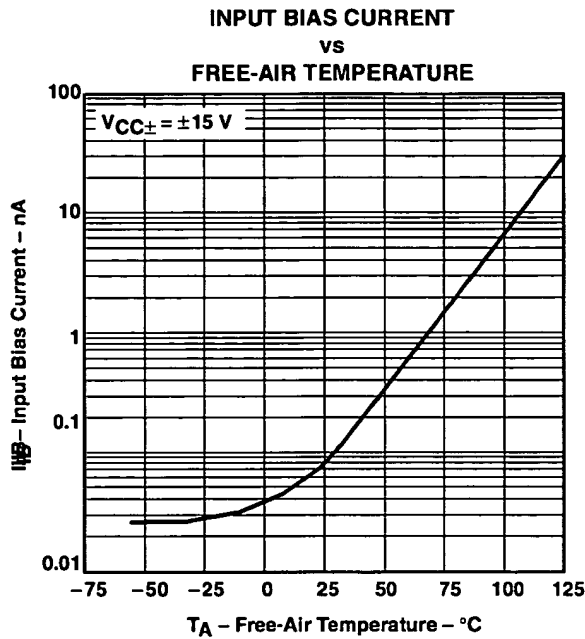


Figure 4

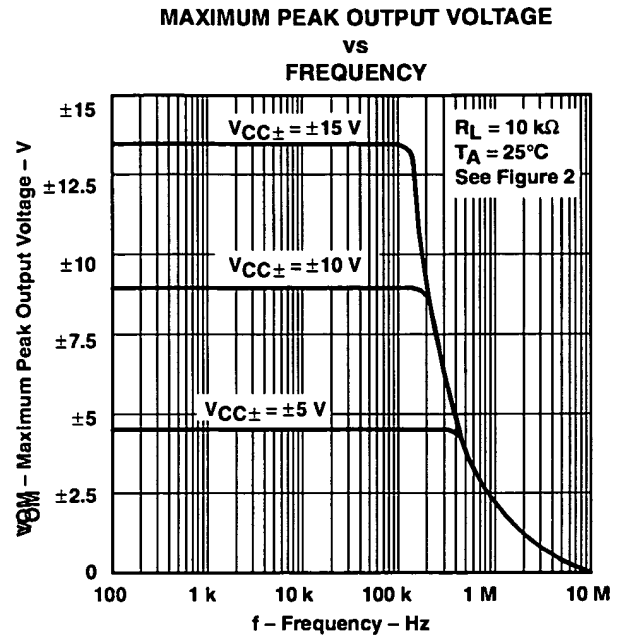


Figure 5

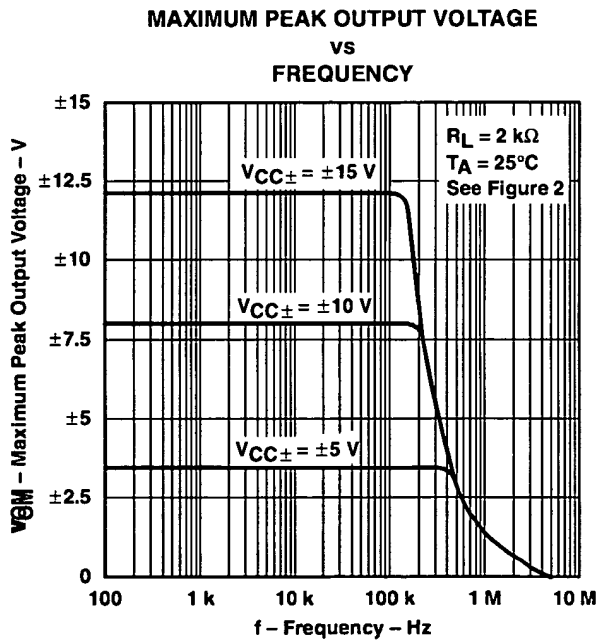


Figure 6

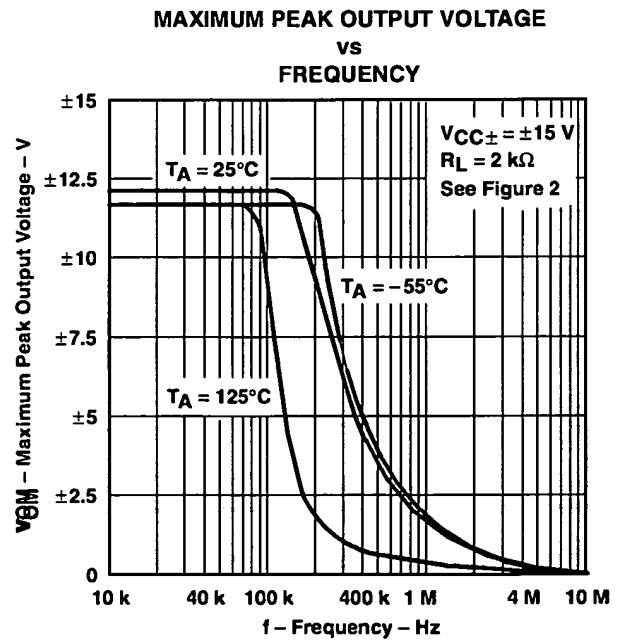


Figure 7

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

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TYPICAL CHARACTERISTICS†

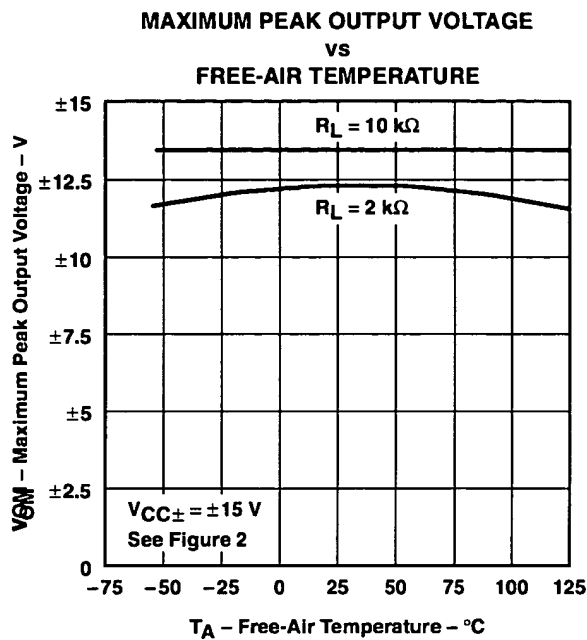


Figure 8

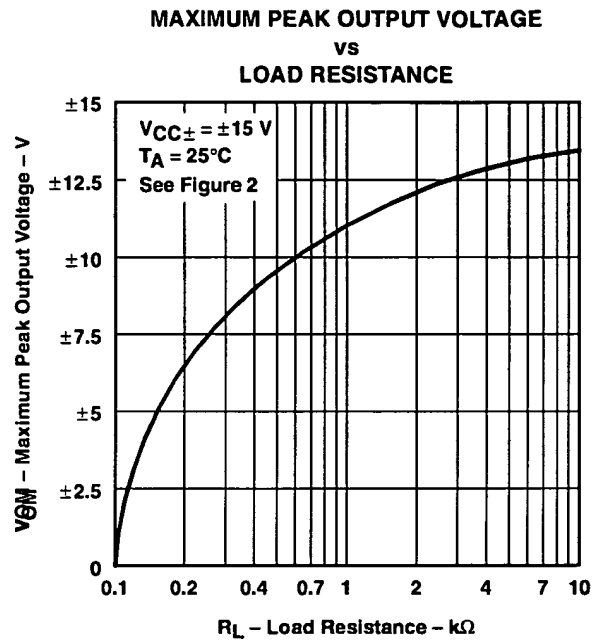


Figure 9

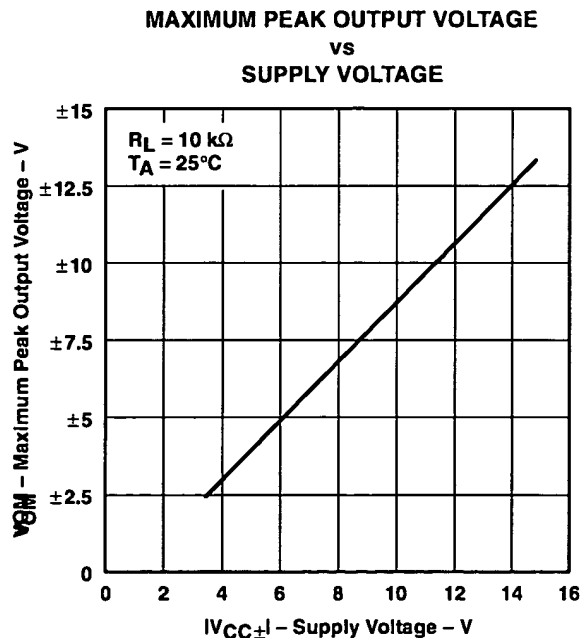


Figure 10

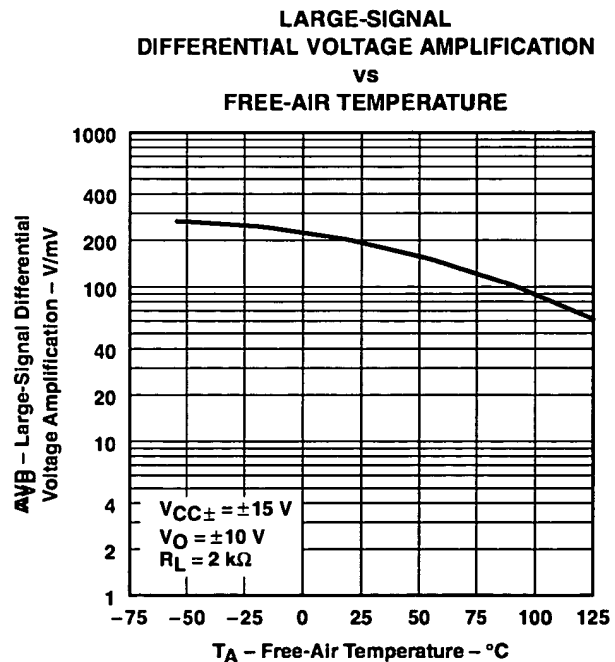


Figure 11

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

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TYPICAL CHARACTERISTICS†

**LARGE-SIGNAL
DIFFERENTIAL VOLTAGE AMPLIFICATION
AND PHASE SHIFT**

vs
FREQUENCY

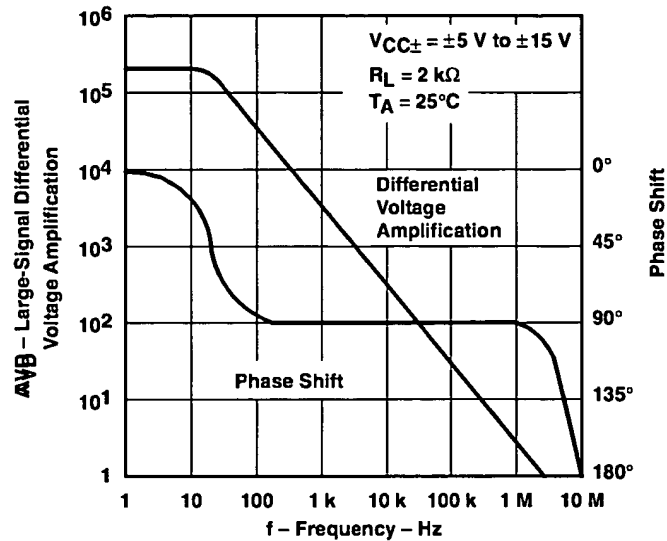


Figure 12

**NORMALIZED UNITY-GAIN BANDWIDTH
AND PHASE SHIFT**

vs
FREE-AIR TEMPERATURE

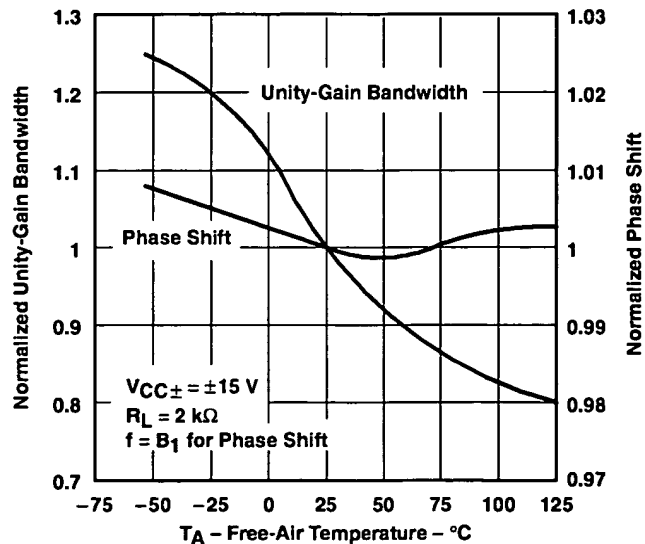


Figure 13

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.



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TYPICAL CHARACTERISTICS†

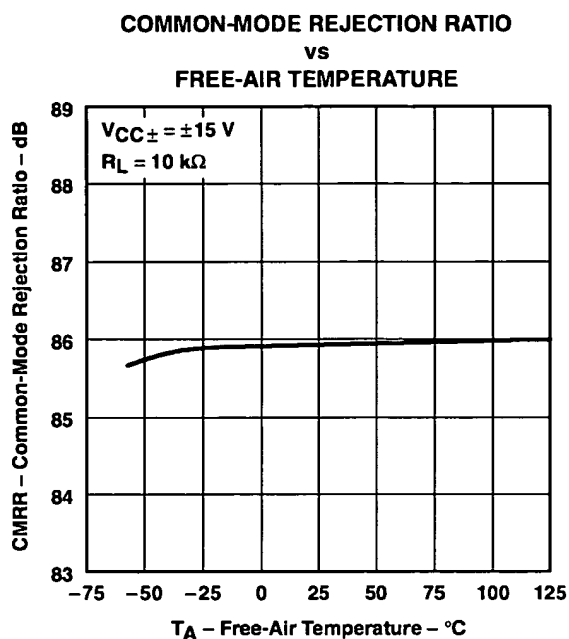


Figure 14

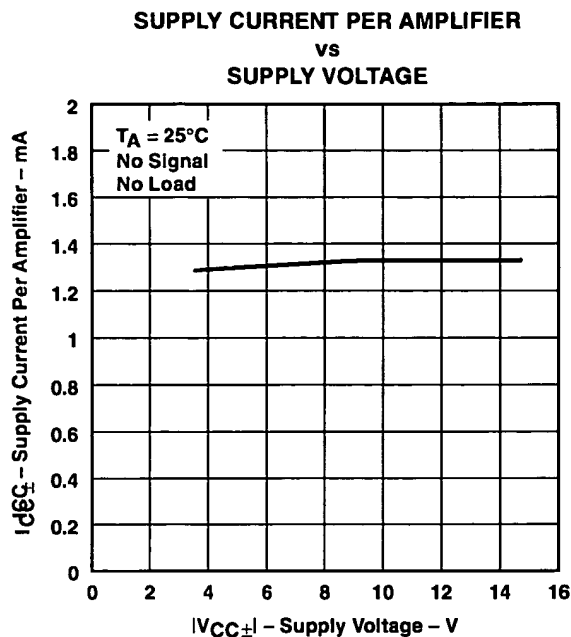


Figure 15

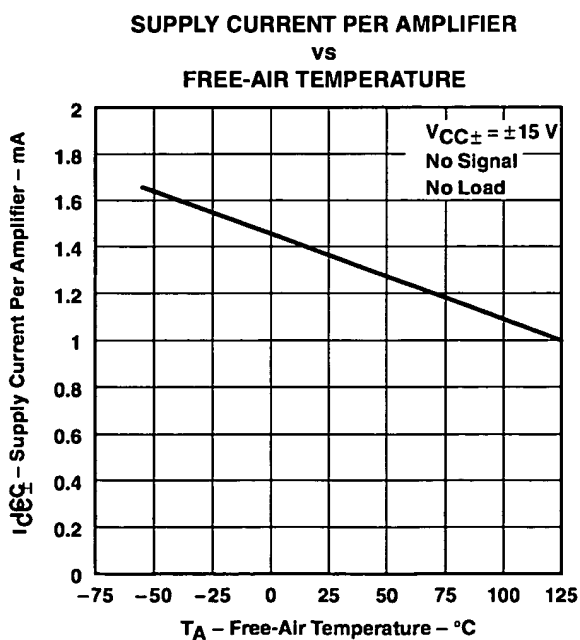


Figure 16

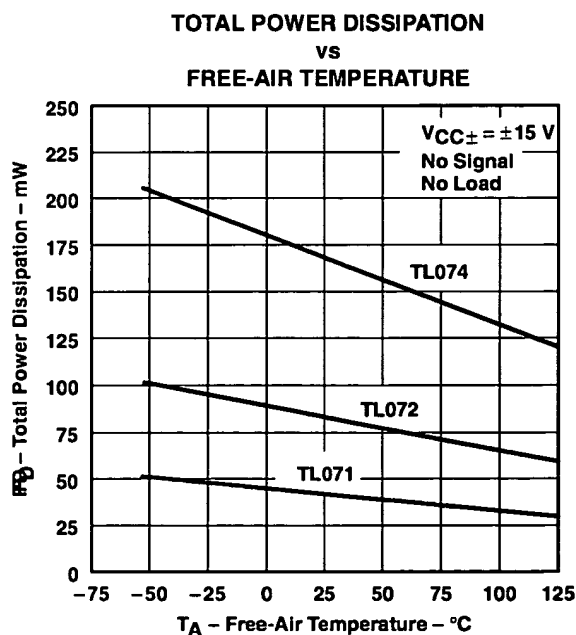


Figure 17

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

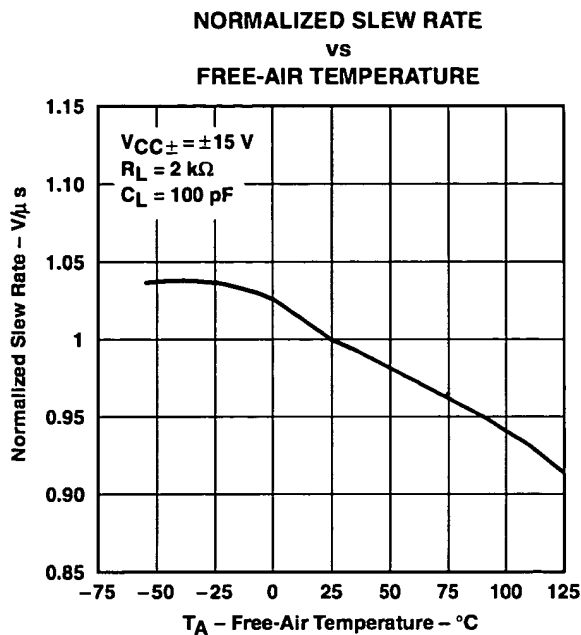


Figure 18

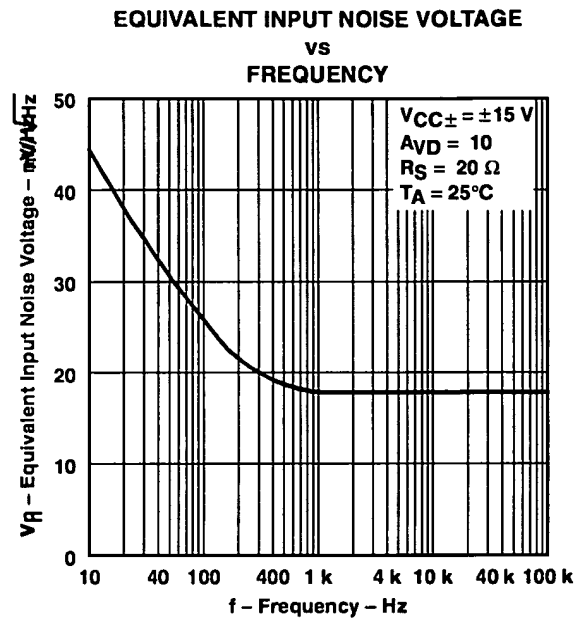


Figure 19

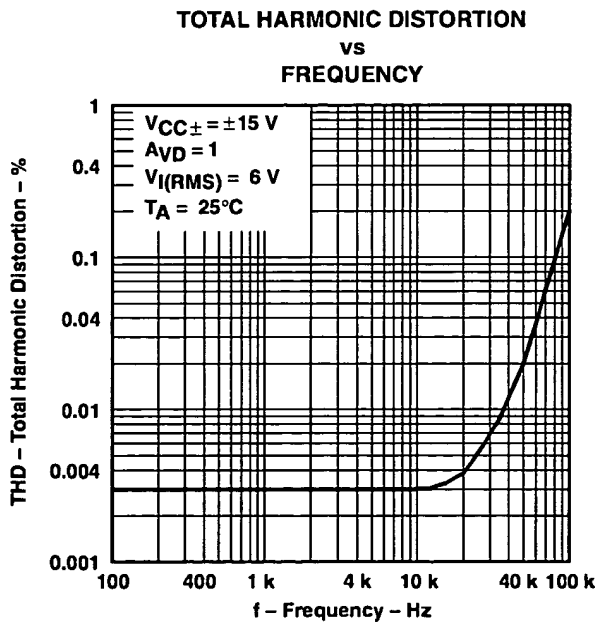


Figure 20

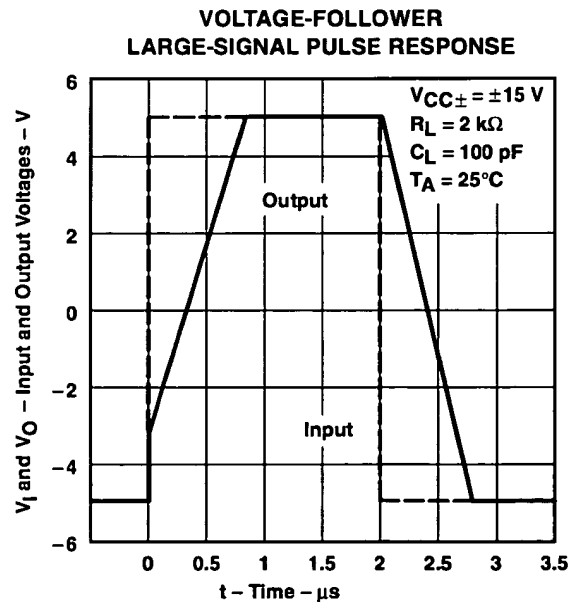


Figure 21

TYPICAL CHARACTERISTICS

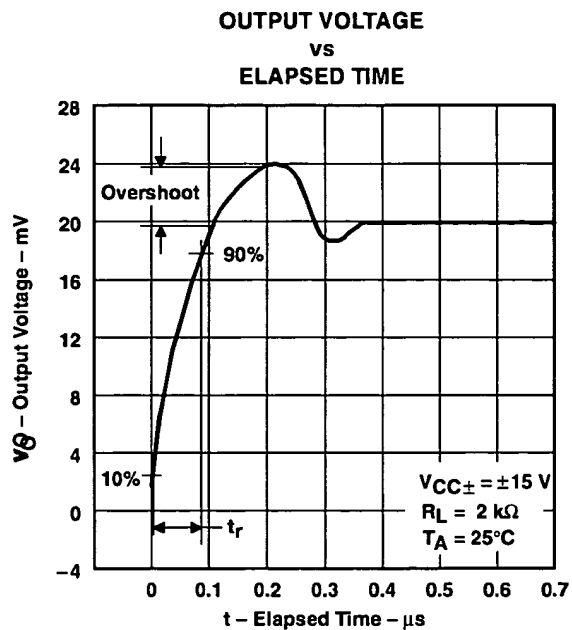


Figure 22

APPLICATION INFORMATION

Table of Application Diagrams

APPLICATION DIAGRAM	PART NUMBER	FIGURE
0.5-Hz square-wave oscillator	TL071	23
High-Q notch filter	TL071	24
Audio-distribution amplifier	TL074	25
100-kHz quadrature oscillator	TL072	26
AC amplifier	TL071	27

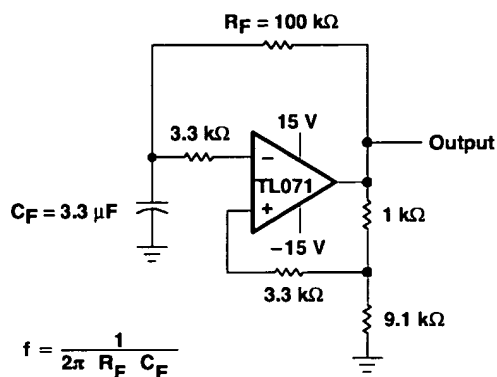


Figure 23. 0.5-Hz Square-Wave Oscillator

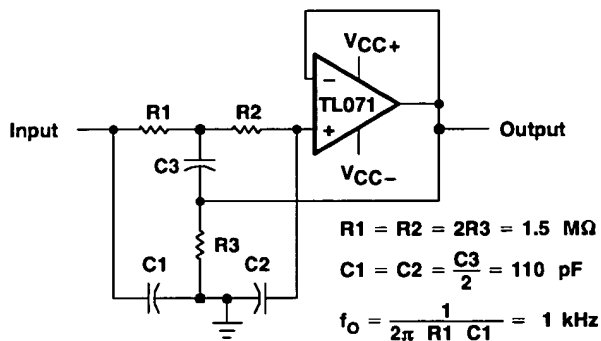


Figure 24. High-Q Notch Filter

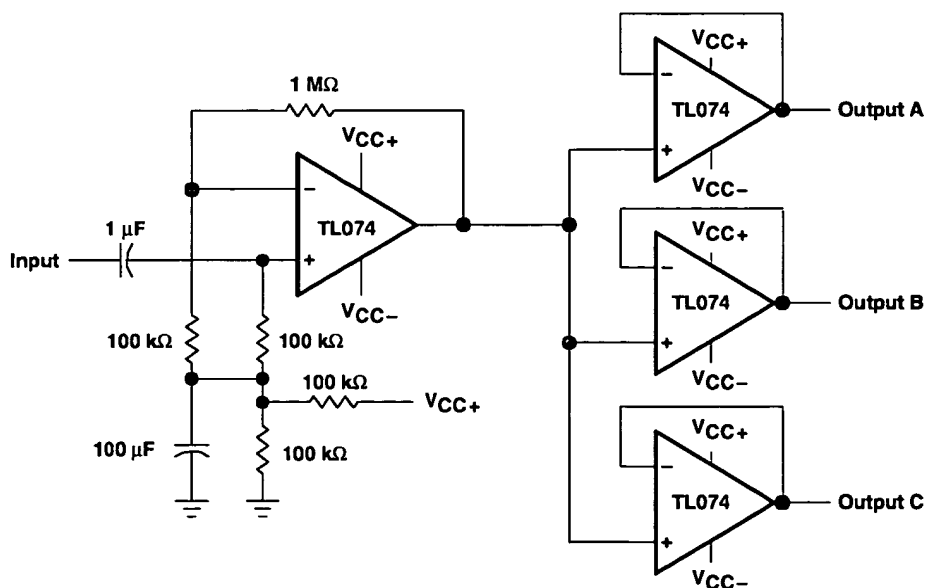
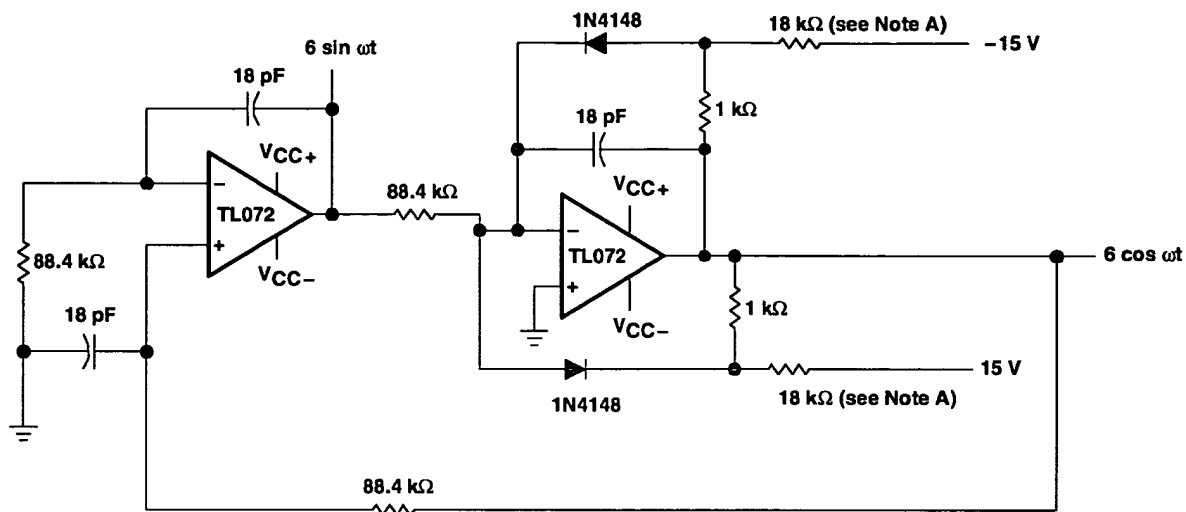


Figure 25. Audio-Distribution Amplifier

TL071, TL071A, TL071B, TL072
TL072A, TL072B, TL074, TL074A, TL074B
LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS
 SLOS080D – SEPTEMBER 1978 – REVISED AUGUST 1996

APPLICATION INFORMATION



NOTE A: These resistor values may be adjusted for a symmetrical output.

Figure 26. 100-kHz Quadrature Oscillator

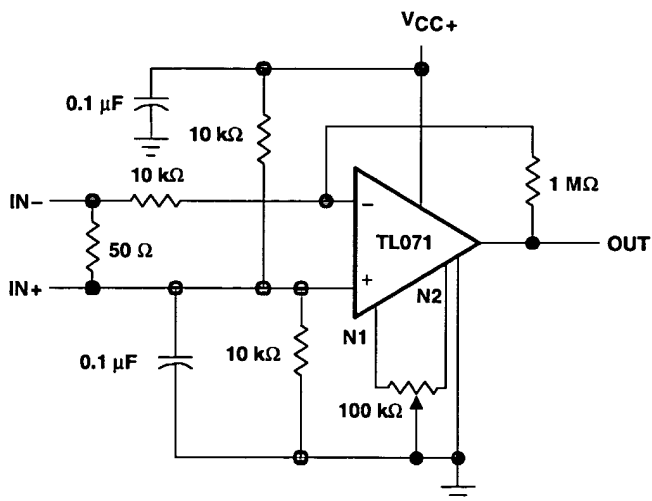


Figure 27. AC Amplifier

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